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CORR. to FR 1227668

PATENT SPECIFICATION

856,599

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Application made in United States of America on June 16, 1958

Complete Specification Published: December 21, 1960

Index at Acceptance:—**Classes 110(1), D2B2; and 110(3), B2(B3:C).**

International Classification:—F02c, F04d.

COMPLETE SPECIFICATION

DRAWINGS ATTACHED

Improvements relating to Axial-Flow Compressors

We, GENERAL MOTORS CORPORATION, a Company incorporated under the laws of the State of Delaware in the United States of America, of Grand Boulevard in the City of Detroit, State of Michigan in the United States of America (Assignees of HARVEY WILLIAM WELSH) do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to axial-flow compressors, such as may be used in gas turbine engines.

The main object of the invention is constructions which permit a stator vane ring to "float" to accommodate any misalignment there may be with respect to the rotor blades, and or any effects due to thermal expansion.

The scope of the invention is defined by the appended claims and how it may be carried out is hereinafter particularly described with reference to the accompanying drawings, in which:—

Figure 1 is a diagrammatic illustration of a gas turbine engine with parts broken away and in section;

Figure 2 is an enlarged cross-sectional view of a portion of the compressor of Figure 1 showing one embodiment of this invention;

Figure 3 is an enlarged cross-sectional view of portions of the compressor of Figure 1, sectioned on the line 3-3 of Figure 1;

Figure 4 is a view of a detail of Figure 2, sectioned on the line 4-4 of Figure 2; and

Figures 5, 6 and 7 illustrate modifications of the construction of Figure 2.

Referring now to the drawings and more particularly to Figure 1, there is shown therein diagrammatically a gas turbine engine 10 having a compressor 12, diffuser 14, a combustion system 16 having a number of combustion chambers 18, a turbine section 20, and an exhaust nozzle 22. The compressor 12 is composed of a number of stages, each stage including a row of rotor blades 24 and a row of stator vanes 26, the rotor blades being fixed to a rotor drum or rotor wheels to be driven by the turbine drive shaft (not shown), and the stator vanes being secured to the engine casing in a manner to be described.

Referring now to Figures 2 and 3, illustrating one embodiment of the invention, the rotor blades 24 are fixed to the rotor 28.

Each row of stator vanes 26 is made up of two semi-annular assemblies which together make up a complete vane ring. Each assembly comprises an outer shroud segment 25, an inner shroud segment 27, and vanes 26 fixed to the shroud segments.

Stator vanes 26 each consist of hollow vanes having tenons 32 inserted through suitable opening in the inner shroud 27 comprising two annular U-shaped reinforcing stiffeners 34 and 36 nested together and brazed at 38 to the blade. Each of the stiffeners has radially inwardly directed flanges 40 and 42, with the flanges on the downstream side extending further radially inwardly than the flanges on the upstream side to permit the connection of the stationary seal member 44 thereto by rivets 46. The seal 44 has a lip 48 contacting with the rotor 28 to provide an interstage seal.

The stator vanes 26 at their tips are inserted through the outer shroud 25 comprising two annular sheet metal shroud rings 50 and 52, shroud rings 50 extending axially beyond the edges of the vanes and having beads 54 and 56 rolled therein to form two radial flanges 58, each one portion of a stage seal. The shroud ring 50 is brazed or welded to the flat shroud ring 52 at the beads 54 and 56, with both

shroud rings being fixed to the vanes 26 by either brazing or welding. Connected to the outer surface of shroud ring 50 by brazing or welding are a number of circumferentially spaced strap-like flexible member 60 extending obliquely from the shroud ring 50, as seen in Figure 4. At their outermost points, each of the strap-like members 60 is fixed to a shouldered nut 62 held against a boss or bushing 64 by a bolt 70 screwed into the thread of nut 62. The boss 64 projects through an opening in an annular reinforcing channel 68 and an opening 66 in the compressor casing 30, the boss 64 and channel 68 being welded to each other and to the casing.

As seen in Figures 2, 3 and 4, circumferentially spaced on the casing 30 from the bosses 64 are a number of other bosses or bushings 72 welded to the casing and reinforcing channel 68 co-operating with other shouldered nuts 74 having fixed thereon circumferentially spaced flexible strap-like members 76 similar to the strap-like members 60. At their opposite ends 78, the strap-like members 76 are secured to a rotor blade shroud ring 80 overlying the tips of the rotor blades 24. The shouldered nuts 74 are held against the bosses 72 by bolts 82. The shroud ring 80 has flanges 84 and 86 in contact with the flanges 58 of the adjacent stator vane shroud ring 50 to complete the stage seal, thereby preventing the communication of hot gases to the casing 30. From a consideration of Figure 3, it will be seen that the stator vane assembly, rotor blade shroud ring 80, and the stage seals are supported by the casing through the bolt and nut members circumferentially spaced around the engine casing in radial alignment with the rotor blades 24.

To assist the assembly of the compressor, as seen in Figure 1, the annular stator shrouds 50, 52 and rotor blade shroud rings 80 are each made in two 180° segments joined together at their respective abutting edges by means of locking means shown in detail in Figure 3.

As seen in Figure 3, each of the two 180° vane segments has welded thereto at one of its ends 90 a lug 92 having an end surface 94 and a hinge pin cross shaft 96. Pivoted on cross-shaft 96 is a lever member (not visible in Fig. 3) having a hinge pin cross-shaft 100 pivotally supporting a toggle or catch member 102. Toggle 102 is curved at 104 to co-operate with the rounded raised portion 106 of a lug 108 welded or brazed to the end of the other 180° vane segment. Lug 108 has an end surface 110 to abut against surface 94. The two lugs 92 and 108 are bored circumferentially for the insertion of an aligning pin 112 having a press fit in one of the lugs.

To join the segments, their two adjacent ends are brought together with the aligning pin 112 engaging in the opposite bore 116. The lever member carrying pin 100 is then raised out of the position shown in Fig. 3, slackening the toggle 102 so that the toggle may be engaged with the lug 108. The lever carrying pin 100 is pivoted about cross-shaft 96 to tighten toggle 102 and circumferentially draw the two vane segments together in a secure manner with lugs 92 and 108 abutting at 94 and 110. The rotor blade shroud segments are locked together in the same manner as the vane segments. The compressor casing also consists of two halves joined together at their abutting flanged edges 88 by bolts (Figure 1).

To assemble the compressor, the stator vanes 26 of one compressor half are inserted through and welded to both the inner and outer shrouds 27 and 25. The shouldered nuts 62 and 74 connected to the strap-like members 60 and 76 are then placed radially under the bosses 64 and 72 of one half of the casing 30 and are secured by the bolts 70 and 82. This assembled half of the casing is then fitted over the rotor and its blades, the other 180° segments of the vane assemblies and rotor shrouds are connected thereto by the locking means in Figure 3, and the other half of the compressor casing is then bolted to the first half, followed by the bolts 70 and 82 being inserted therein to secure the stator vane assemblies and rotor blade shroud rings to this half of the casing. This construction provides good stress distribution in the stator vanes and reduces engine vibration.

In Figure 5, a modification of the construction of Figures 2-4 is shown. In this modification, the stator vane assemblies are connected to the casing at a point that is radially in line with the assemblies instead of obliquely as shown in Figures 2-4.

In Figure 5, each of the stator vanes 26 is inserted through and welded to an outer shroud 117 comprising two U-shaped radially spaced shroud rings 118 and 120 joined by welding or brazing at their flanges 122. Secured at one end to the outside surface of the shroud 120 are a number of circumferentially spaced flexible strap-like members 124 having their other ends fixed to shouldered nuts 126 in a manner similar to that shown in Figure 2. The shouldered nuts 126 co-operate with circumferentially spaced bosses 128 secured to the casing 30 and are held thereto by bolts 130. Between adjacent stator vane assemblies is a rotor blade shroud ring 132 having flanges 134 which contact the radial flanges 122 of the vane shroud rings. Each rotor blade shroud ring 132 is connected to the casing by a number of flexible strap-like members 136 welded to the outside surface of the shroud ring at one end and fixed at the other end to shoul-

dered nuts 138 into which are screwed bolts 140 inserted through bosses 142 secured to the casing.

Figure 6 shows another modification of the compressor construction wherein the outer portions of each of the stator vanes 26 of each row are inserted through and welded to an annular flat sheet metal strip 176 rolled at its ends 178 to form the stationary portion of a stage seal. Each of the rotor blades 24 is welded at its tips to a shroud ring 179 comprising the rotatable part of a seal, the shroud ring consisting of a corrugated metal strip 180 welded to and positioned between two flat annular strips 182 and 184. The strip 182 is radially flanged at its edges 186 and 188 to press against the stationary portion 190 of the strip 176, and a projecting portion 192 of the engine casing 30.

The stator vanes also extend through and are welded to a sheet metal shroud ring 194 having axially extending flanges 196 welded or brazed to the flat portion of the strip 176. Similarly to the Figures 2-5 modifications, a number of circumferentially spaced strap-like member 198 are welded at one end 200 to the ring 194, and at their other ends to shouldered nuts 202 abutting bosses 204 fixed to the casing 30. Bolts 206 are inserted through the bosses 204 and threadedly engage the shouldered nuts 202 to fix the axial location of the hat-section shroud ring 194 and shroud 176, thereby locating and supporting the stator vanes 26.

Figure 7 shows still another modification of the compressor structure, this construction varying from Figure 6 in details of the shroud rings through which the stator vanes 26 extend. In this modification, the stator vanes 26 extend through and are welded or brazed to an annular flat strip 208 forming an internal stiffening ring at the tip of the blades, the strip having an axially extending sealing flange 210 at its upstream edge.

The vanes also extend through and are welded to an outer stiffening ring 212 having beads 214 and 216 rolled therein to provide axially extending flanges 218 and 220 forming the stationary portions of a stage seal. Suitably attached to the underside of the edges of the flanges 218 and 220 are sealing materials co-operating with the radially flanged portions 222 of the rotor blade shroud ring 224. Secured to the outer surface of the hat-shaped ring 212 are a number of circumferentially spaced strap-like flexible members 226 having shouldered nuts 228 fixed thereto at their downstream ends, the nuts co-operating with bosses or bushings 230 brazed to the compressor casing 30. Bolts 232 are inserted through each of the bushings to threadedly engage the shouldered nuts to support the stator vane stiffener rings 208, 212, stationary portions of the gas seals 210, 218 and the stator vanes 26 in a "floating" manner such that expansion or contraction of the same with an increase or decrease in the temperature of the gas flowing through the compressor is permitted.

The Figures 6 and 7 modifications of the compressor are assembled in a manner similar to that of Figures 2-5.

WHAT WE CLAIM IS:—

1. An axial-flow compressor in which a ring of stator blades comprising inner and outer shrouds interconnected by the blades, is supported from the casing by circumferentially-distributed flexible metal strips, each fixed at one end to the casing by a threaded nut and bolt, and fixed at the other end to the outer shroud.

2. A compressor according to claim 1 in which a stationary rotor blade shroud ring is supported from the casing by circumferentially-distributed flexible metal members.

3. A compressor according to claim 2, in which the rotor blade shroud ring is in sealing contract with the outer shroud of the stator ring.

4. A compressor according to claim 3, wherein the inner shroud of the stator ring carries a seal ring adapted to contact the rotor.

5. An axial-flow compressor, substantially as hereinbefore particularly described with reference to Figures 1-4 of the accompanying drawings.

6. An axial-flow compressor, substantially as hereinbefore particularly described with reference to Figure 5 of the accompanying drawings.

7. An axial-flow compressor, substantially as hereinbefore particularly described with reference to Figure 6 of the accompanying drawings.

E. WILLIAMSON,
Chartered Patent Agent.

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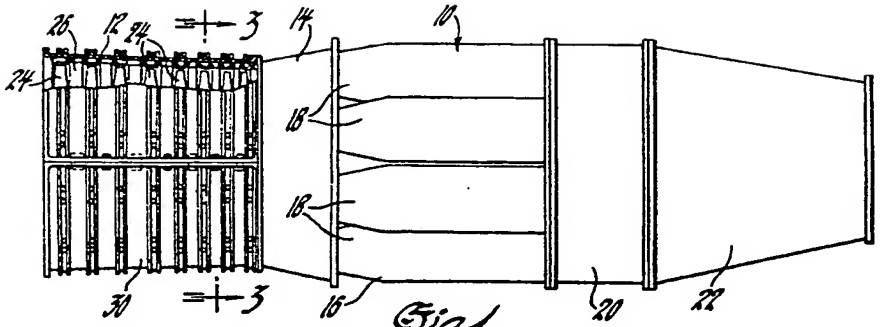
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Fig. 1

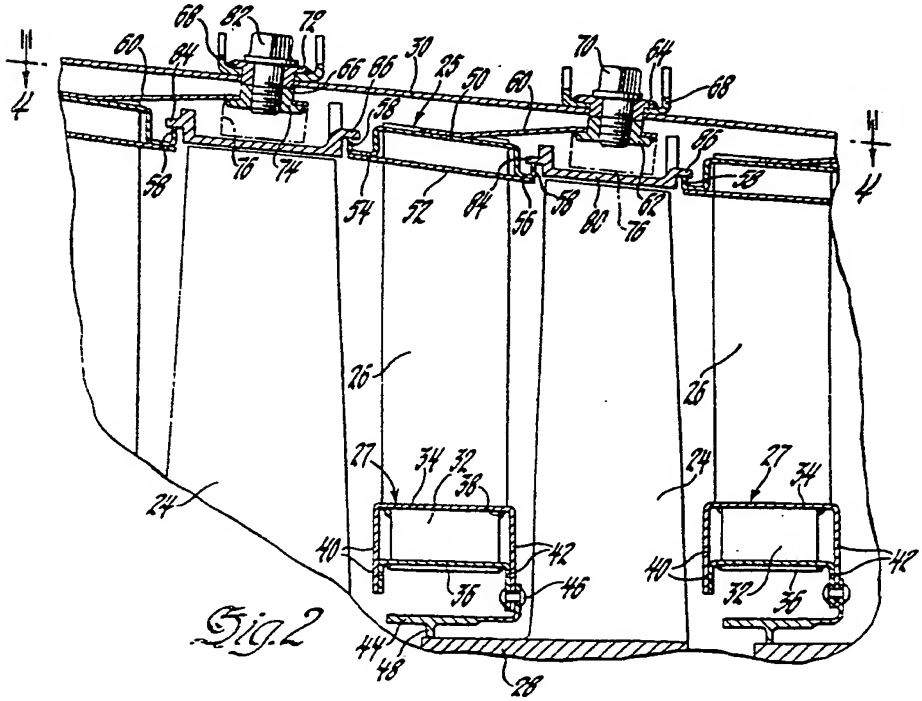
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Fig. 2

856,599 COMPLETE SPECIFICATION

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SHEETS 1 & 2

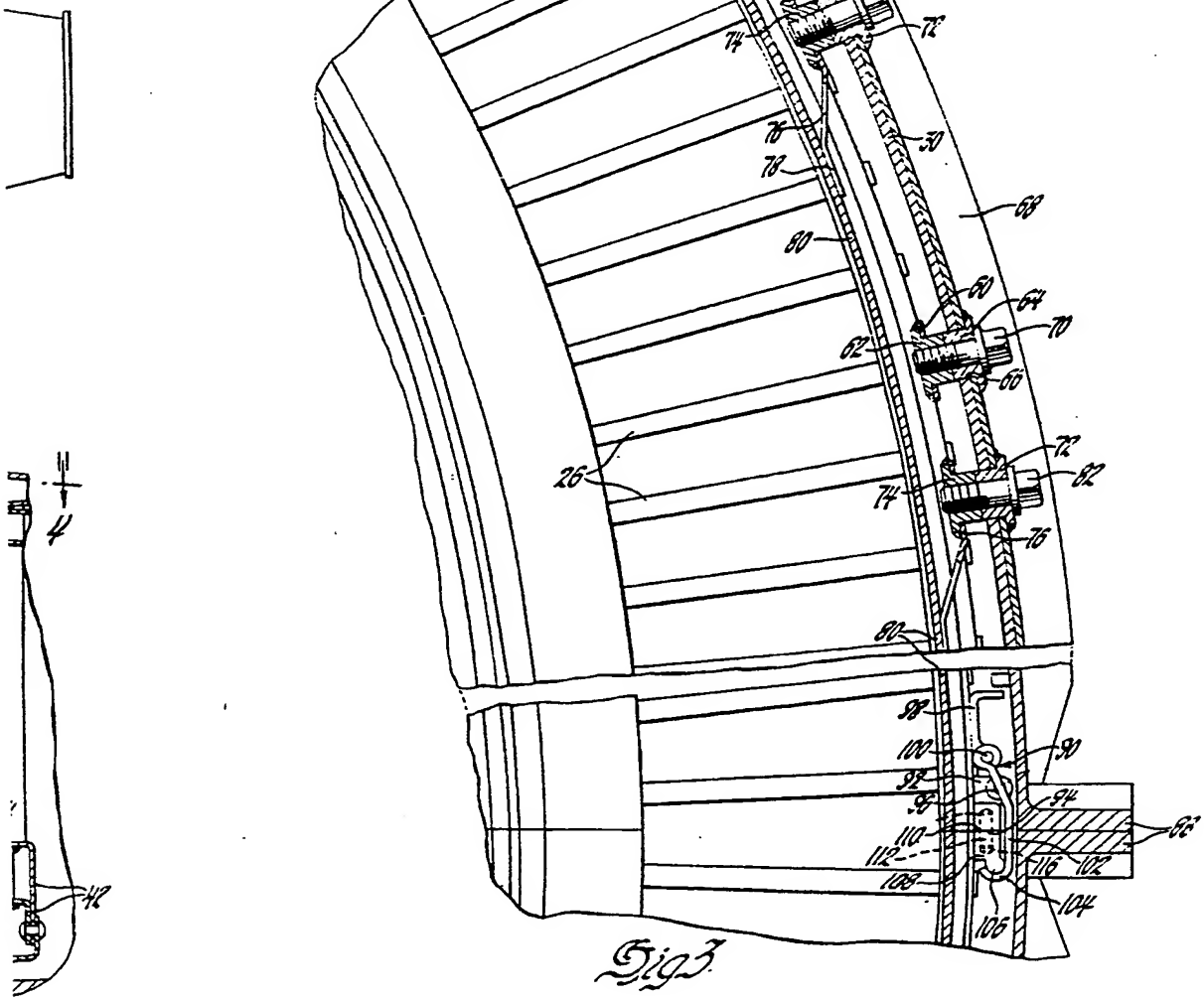

Fig 3

856,599 COMPLETE SPECIFICATION
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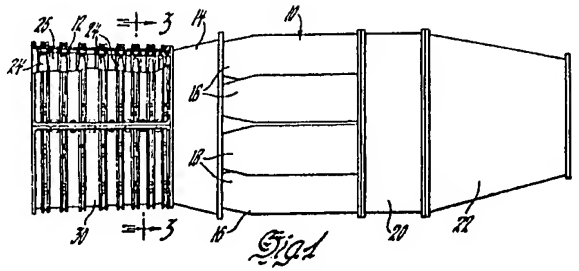

Fig.1

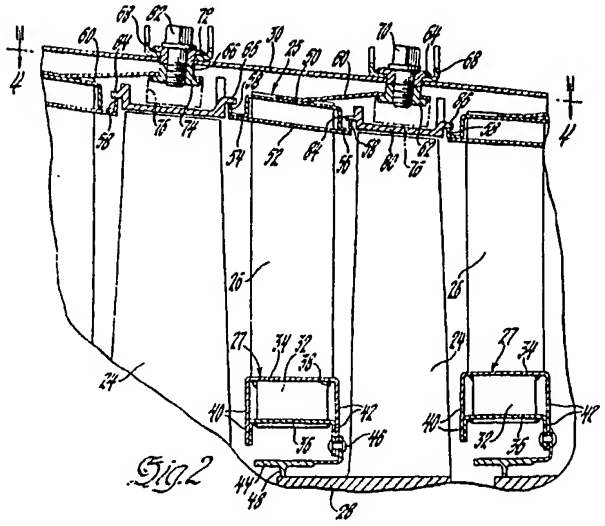

Fig.2

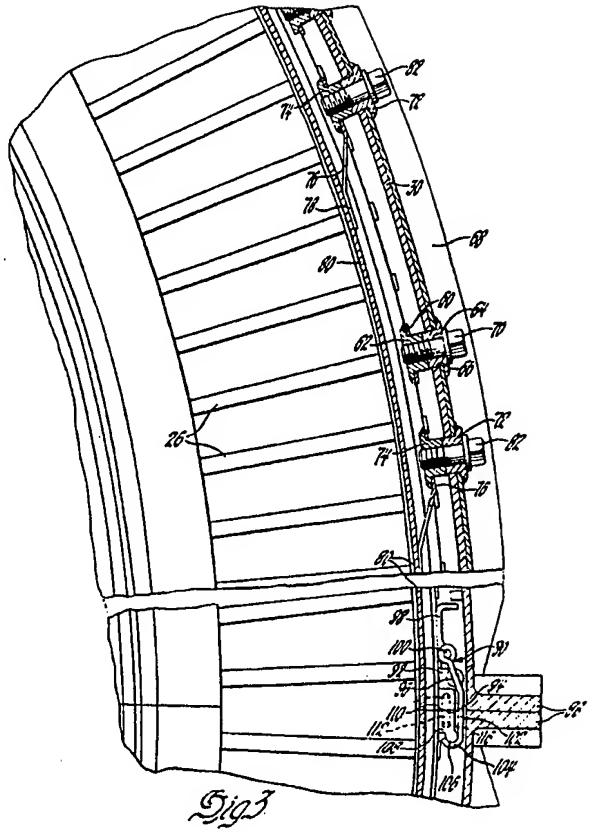

Fig.3

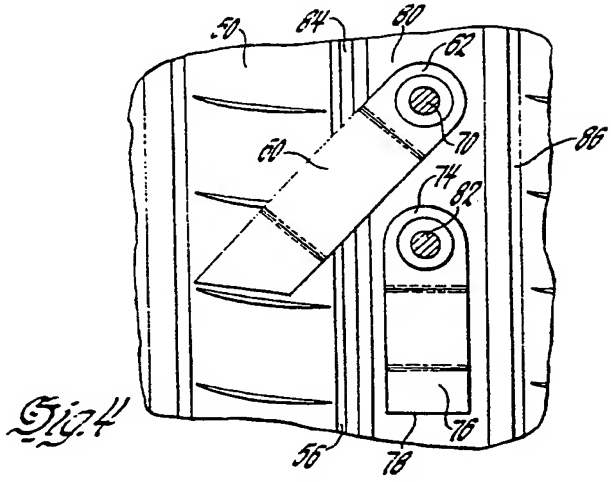
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Fig. 4

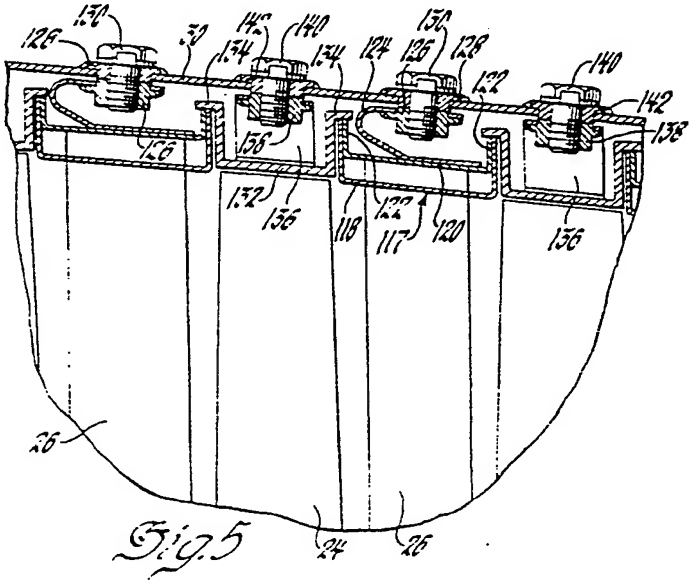
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Fig. 5

856,599 COMPLETE SPECIFICATION

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SHEETS 3 & 4

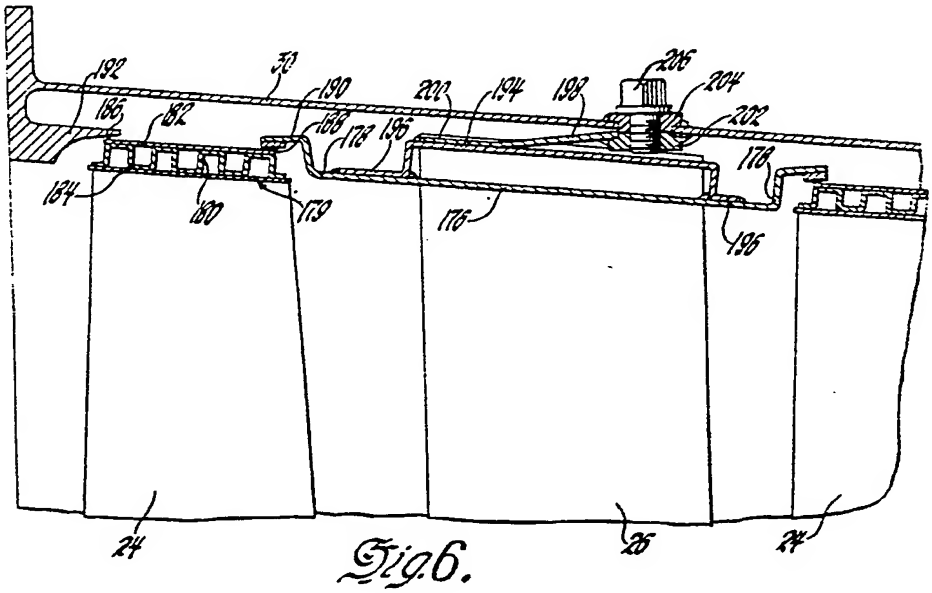

Fig. 6.

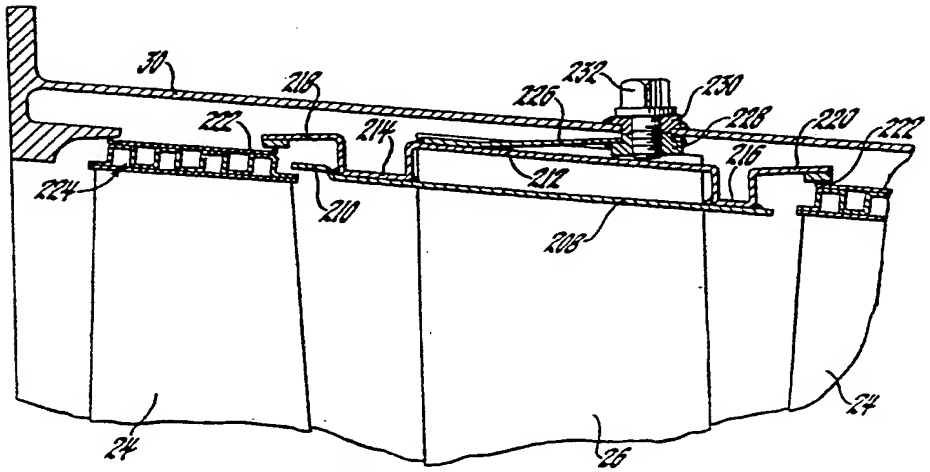

Fig. 7.

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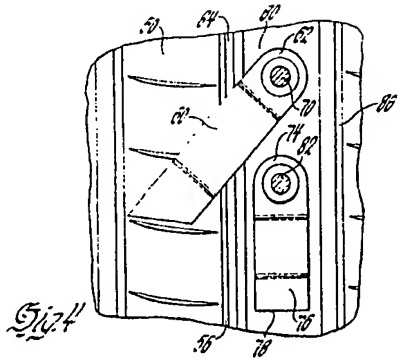

Fig.4.

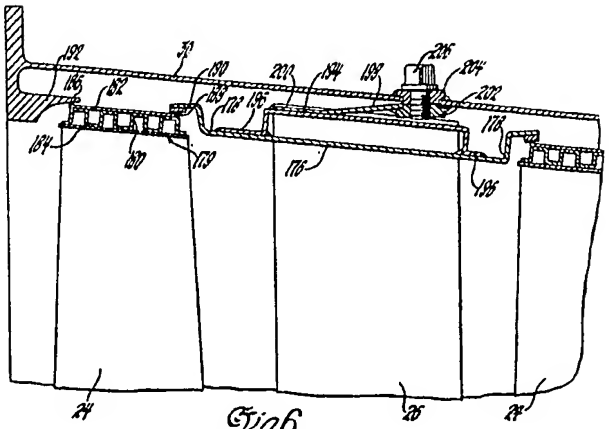

Fig.6.

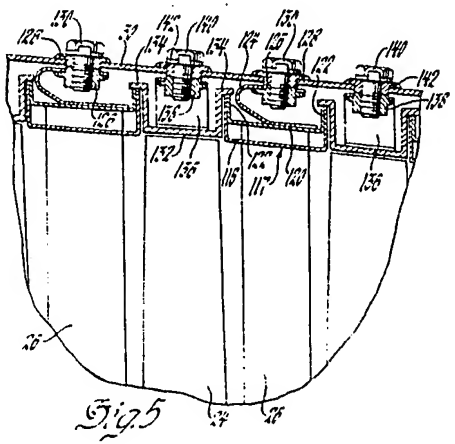

Fig.5

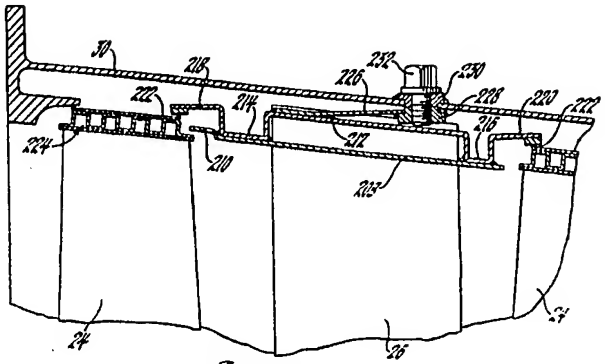

Fig. 7.